

# 1 Derivation of WHDG Kinematic Limits

First, see Fig. 1 for notation. For a massless parent parton of momentum  $P$ , a massless radiated gluon of momentum  $k$ , and a final massless parent parton momentum of  $p$  we have that

$$P = (E, 0, 0, E) = [E^+, 0, 0], \quad (1)$$

where  $(, )$  denote the usual 4-momenta,  $[, ]$  denote light-cone momenta, and we choose the normalization between the two as  $E^+ = 2E$ . Taking  $x$  to be the fraction of **plus** momentum carried away by the radiated gluon then

$$k = [xE^+, \frac{\mathbf{k}_\perp^2}{xE^+}, \mathbf{k}_\perp] \quad (2)$$

$$p = [(1-x)E^+, \frac{(\mathbf{q}_\perp - \mathbf{k}_\perp)^2}{(1-x)E^+}, \mathbf{q}_\perp - \mathbf{k}_\perp]. \quad (3)$$

The assumption of eikonicity requires that the parent parton continues essentially along its original path. This clearly implies  $p^+ \gg p^-$ ; i.e. that radiating a gluon doesn't make the parent parton go backwards. Similarly we require that the radiated gluon go in the forward direction,  $k^+ \gg k^-$ ; i.e. radiative energy loss does not lead to an energy gain. The first of these conditions implies that ( $k_\perp = |\mathbf{k}_\perp|$ )

$$(1-x)E^+ \gg |\mathbf{q}_\perp - \mathbf{k}_\perp| \approx k_\perp, \quad (4)$$

where we note that  $q_{max} = \sqrt{6ET} \ll k$  for  $E \gg T$ ; the second condition that

$$xE^+ \gg k_\perp. \quad (5)$$

Taking the  $k_\perp$  integral cutoff to occur precisely at equality for these conditions leads to

$$k_{max} = \min(x, 1-x)E^+ \quad (6)$$

$$= 2 \min(x, 1-x)E \quad (7)$$

$$\approx 2x(1-x)E, \quad (8)$$

where the last line is used in the WHDG implementation for convergence reasons and makes little difference in the final result (see the last TECHQM meeting).

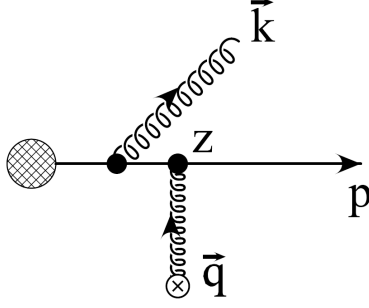


Figure 1: One of the diagrams contributing to the first order in opacity matrix element.  $\mathbf{q}$  is the momentum transfer between the parent parton and the in-medium scattering center.  $\mathbf{k}$  is the momentum carried off by the radiated gluon.  $z$  is the distance from the hard production vertex of the parent parton and the scattering center. Figure adapted from Djordjevic and Gyulassy, Nucl.Phys.A733:265-298, 2004.